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IS 15882 (2009): BALLASTS FOR DISCHARGE LAMPS (EXCLUDING TUBULAR FLUORESCENT LAMPS) — PERFORMANCE REQUIREMENTS [ETD 23: Electric Lamps and their Auxiliaries]

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Indian Standard

BALLASTS FOR DISCHARGE LAMPS (EXCLUDING TUBULAR FLUORESCENT LAMPS) — PERFORMANCE REQUIREMENTS

ICS 29.140.30

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

May 2011 **Price Group 6**

Electric Lamps and Their Auxiliaries Sectional Committee, ETD 23

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Electric Lamps and Their Auxiliaries Sectional Committee had been approved by the Electrotechnical Division Council.

This standard covers performance requirements for ballasts for discharge lamps. Safety requirements are covered in a separate Indian Standard [IS 15885 (Part 2/Sec 9)[1] 'Safety of lamp control gear: Part 2 particular requirements, Section 9 Ballasts for discharge lamps (excluding fluorescent lamps)'].

In order to obtain satisfactory performance of discharge lamps and their associated ballasts, it is necessary that certain features of their design be properly coordinated. Therefore, it is essential that specifications for them be written in terms of measurements made against some common baseline of reference, which should be permanent and reproducible.

These conditions may be fulfilled by special or selected inductive-type ballasts, called reference ballasts. These ballasts may be used for testing ordinary ballasts and for the selection of reference lamps.

Moreover, the testing of ballasts requires a clear definition of testing methods. This testing will, in general, be made with reference to lamps and, in particular, by comparing results obtained on such lamps with these ballasts and with the reference ballast.

Because of the special characteristics of discharge lamps, two ranges of supply voltage variation had to be considered. Whenever safety is involved, the classical range of variation from 90 percent to 110 percent of the rated supply voltage is retained, but for certain clauses where only operational conditions are concerned a smaller range from 92 percent to 106 percent of the rated value has been considered.

The safety and performance requirement of ballast for high pressure mercury vapour lamps were earlier covered in IS 6616. However no Indian Standard exists for the performance requirements of ballast for other discharge lamps (excluding tubular fluorescent lamps). However with a view to align Indian Standards in line with International Standards (IEC), it has been decided to formulate separate safety standard for safety and performance requirements.

This standard unlike IS 6616 covers only the performance requirements of ballasts and ignitors for all types of discharge lamps (excluding tubular fluorescent lamps). Following additional tests have been incorporated in this standard which were not specified in IS 6616:

a) Circuit power factor, and
b) Magnetic screening.

After the publication of this standard, IS 6616 : 1982 'Specification for ballast for high pressure mercury vapour lamps' shall be withdrawn.

This standard is based on IEC 60923 : 2006 'Auxiliaries for lamps, ballasts for discharge lamps (excluding tubular fluorescent lamps), performance requirements', issued by the International Electrotechnical Commission.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the results of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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[1] Under print.

Indian Standard

BALLASTS FOR DISCHARGE LAMPS (EXCLUDING TUBULAR FLUORESCENT LAMPS) — PERFORMANCE REQUIREMENTS

1 SCOPE

This standard specifies performance requirements for ballasts for discharge lamps such as high-pressure mercury vapour, low-pressure sodium vapour, high-pressure sodium vapour and metal halide lamps. Each section details specific requirements for a particular type of ballast. The standard covers inductive type ballasts for use on ac supplies up to 1 000 V at 50 Hz associated with discharge lamps, having rated wattage, dimensions and characteristics as specified in the relevant Indian Standards.

NOTES

1 For certain types of discharge lamps an ignitor is required.

2 Extension of the standard to cover ballasts incorporating or for use with series capacitors is under consideration.

3 The performance requirements of ballasts for tubular fluorescent lamps are covered by IS 1534 (Part 1).

2 REFERENCES

The following Indian Standards contain provisions, which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
1534 (Part 1) : 1977	Ballasts for fluorescent lamps: Part 1 For switch start circuits (*second revision*)
2500 (Part 1) : 2000	Sampling inspection procedures: Part 1 Attribute sampling plans indexed by acceptance quality level (AQL) for lot-by-lot inspection
9900	High-pressure mercury vapour lamps:
(Part 1) : 1981	Requirements and tests
(Part 2) : 1981	Standard lamp data sheets
9974 (Part 2) : 1981	High-pressure sodium vapour lamps: Part 2 Standard lamp data sheets
10322 (Part 1) : 1982	Luminaires: Part 1 General requirements and tests
14700 (Part 3/Sec 2) : 1999	Electromagnetic compatibility (EMC): Part 3 Limits, Section 2 Limits for harmonic current emissions (equipment input current 16 A per phase)
15885 (Part 1)[1]	Safety of lamp control gear: Part 1 General requirements
15885 (Part 2/Sec 1)[1]	Safety of lamp control gear: Part 2 Particular requirements, Section 1 Starting devices (other than glow starters) — General requirements
15885 (Part 2/Sec 9)[1]	Safety of lamp control gear: Part 2 Particular requirements, Section 9 Ballasts for discharge lamps (excluding fluorescent lamps)

3 TERMINOLOGY

The definitions given in IS 15885 (Part 2/ Sec 9) shall apply.

4 GENERAL NOTES ON TESTS

Tests according to this specification are type tests.

The tests are carried out in the order of the clauses, unless otherwise specified.

One sample is submitted to all tests.

In general all tests are made on each type of ballast or, where a range of similar ballasts is involved, for each rated wattage in the range, or a representative selection from the range, as agreed with the manufacturer.

Reference ballasts and reference lamps shall be in accordance with Annex A and Annex B.

The tests are made under the conditions specified in Annex C.

---

[1] Under print.

All ballasts specified in this standard shall meet the requirements of IS 15885 (Part 1) and IS 15885 (Part 2/Sec 9).

NOTES

1 The requirements and tolerances permitted by this standard are based on testing of a type test sample submitted by the manufacturer for that purpose. In principle this type test sample should consist of units having characteristics typical of the manufacturer's production and be as close to the production centre point values as possible. It may be expected with the tolerances given in the standard that products manufactured in accordance with the type test sample will comply with the standard for the majority of the production. Due to the production spread, however, it is inevitable that there will sometimes be ballasts outside the specified tolerances. For guidance of sampling plans and procedures for inspection by attributes, *see* IS 2500 (Part 1).

2 Attention is drawn to lamp performance standards which contain 'information for ballast design'. This information should be followed for proper lamp operation. However, this standard does not require the testing of lamp performance as part of the type test approval for ballasts.

5 MARKING

The following additional marking in addition to that specified in IS 15885 (Part 2/Sec 9) is included, if appropriate:

Circuit power-factor, for example, ë 0.85.

5.1 BIS Certification Marking

The lamps may also be marked with the Standard Mark.

The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the license for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

6 BALLASTS DESIGNED TO OPERATE AT VARIOUS SUPPLY VOLTAGES

If ballast is rated for more than one value of supply voltage, it shall comply with the relevant clauses of this specification at all voltages for which it is marked. In case of ballast with taps, it is tested using the appropriate tappings.

7 CIRCUIT POWER-FACTOR

The measured circuit power-factor shall not differ from the marked value by more than 0.05 when the ballast is operated with one or more appropriate lamp(s) and the whole combination is supplied at its rated voltage and frequency.

In cases where a minimum value of the power-factor is required for high power-factor ballast, it shall be 0.85 measured under the conditions stated above. For these high power-factor ballasts, the measured value shall in no case be less than 0.85.

8 SUPPLY CURRENT

At rated voltage, the supply current shall not differ by more than 10 percent from the value marked on the ballast when the latter is operated with a reference lamp.

9 CURRENT WAVEFORM

9.1 Lamp Operating Current Waveform

The maximum ratio of peak value to root-mean-square (rms) value shall not exceed the values in Table 1 when the ballast associated with a reference lamp is operated at its rated voltage.

Table 1 Lamp Operating Current Waveform, Maximum Ratio of Peak Value to rms

Sl No. (1)	Lamp Type (2)	Maximum Ratio of Peak Value to rms (3)
i)	High-pressure mercury	1.9
ii)	Low-pressure sodium[1]	1.6
iii)	High-pressure sodium	1.8

[1] Deviating from this table, for ignitor circuits for low-pressure sodium lamps, the maximum ratio of peak value to rms value of the lamp operating current shall not exceed 2.0 for a short duration, for example, < 0.20 ms, and 1.8 for a longer duration.

9.2 Test Procedure

The peak value of the lamp current shall be determined by means of a calibrated cathode-ray oscilloscope, the resistor R_1 being inserted in the earthed side of the circuit (*see* Fig. 1).

This resistor shall have a sufficiently low value such that the voltage drop shall not exceed 0.5 percent of the nominal lamp voltage.

The oscilloscope is connected with its earth connection on the supply side.

Care is taken to ensure a sufficiently low impedance of the supply for the different frequencies involved. Moreover, the supply voltage distortion of maximum 3 percent [*see* **C-2**(c)] shall be taken into account when evaluating test results. In case of doubt a distortion-free supply is used.

10 MAGNETIC SCREENING

The ballast shall be effectively screened against the influence of adjacent ferro-magnetic materials.

Compliance is checked by the following test.

The ballast is operated at rated voltage with an appropriate lamp. After stabilization, a steel plate 1 mm thick and of length and breadth greater than those

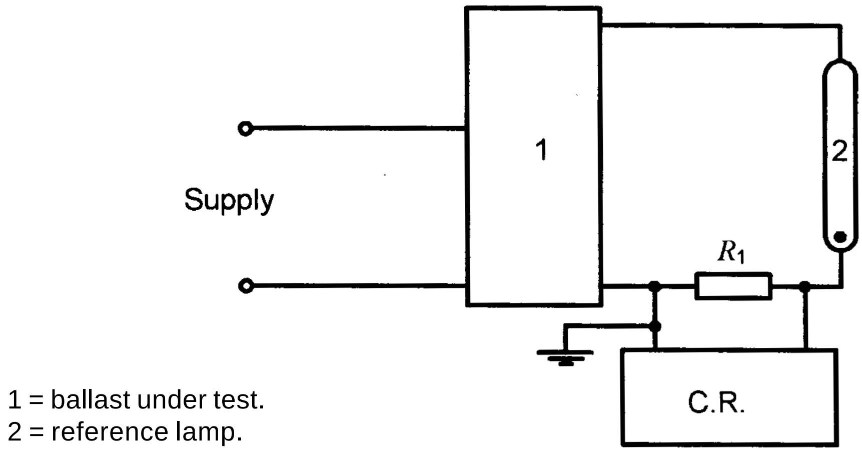


FIG. 1 MEASUREMENT OF CURRENT WAVEFORM

of the ballast under test shall be successively moved into proximity and held at a spacing of 5 mm with each face of the latter. During this operation, the lamp current is measured and this shall not change by more than 2 percent due to the presence of the steel plate.

11 IGNITORS

Ignitors shall conform to the requirements of IS 15885 (Part 2/Sec 1).

12 ELECTRICAL REQUIREMENTS FOR BALLASTS FOR HIGH-PRESSURE MERCURY VAPOUR LAMPS

12.1 Ballast Setting

The ballast shall limit the power and current delivered to a reference lamp to not less than 92.5 percent for the power and not more than 115 percent for the current of the corresponding values delivered to the same lamp when operated with reference ballast. Both the reference ballast and the ballast under test shall have the same rated frequency and each shall be operated at its rated voltage.

Moreover, for any other supply voltage between 92 percent and 106 percent of its rated value, the power delivered by the ballast to the reference lamp shall lie between the limits of 88 percent of the power delivered to the same lamp by the reference ballast when supplied at 92 percent of its rated voltage and the limit of 109 percent of the power delivered to the lamp by the reference ballast when supplied at 106 percent of its rated voltage.

The tests are carried out with a circuit shown in Fig. 2, where switch S_2 in the up position and switch S_1, successively operating the lamp from the reference ballast and the ballast under test.

12.2 Short-Circuit Current

When the ballast is supplied at any voltage between 92 percent and 106 percent of its rated voltage, the short-circuit current passed shall not exceed the values given in IS 9900 (Part 1).

The test circuit shown in Fig. 2, is used with switch S_1 in the up position and switch S_2 in the down position.

12.3 Open-Circuit Voltage (Minimum Voltage for Stable Operation)

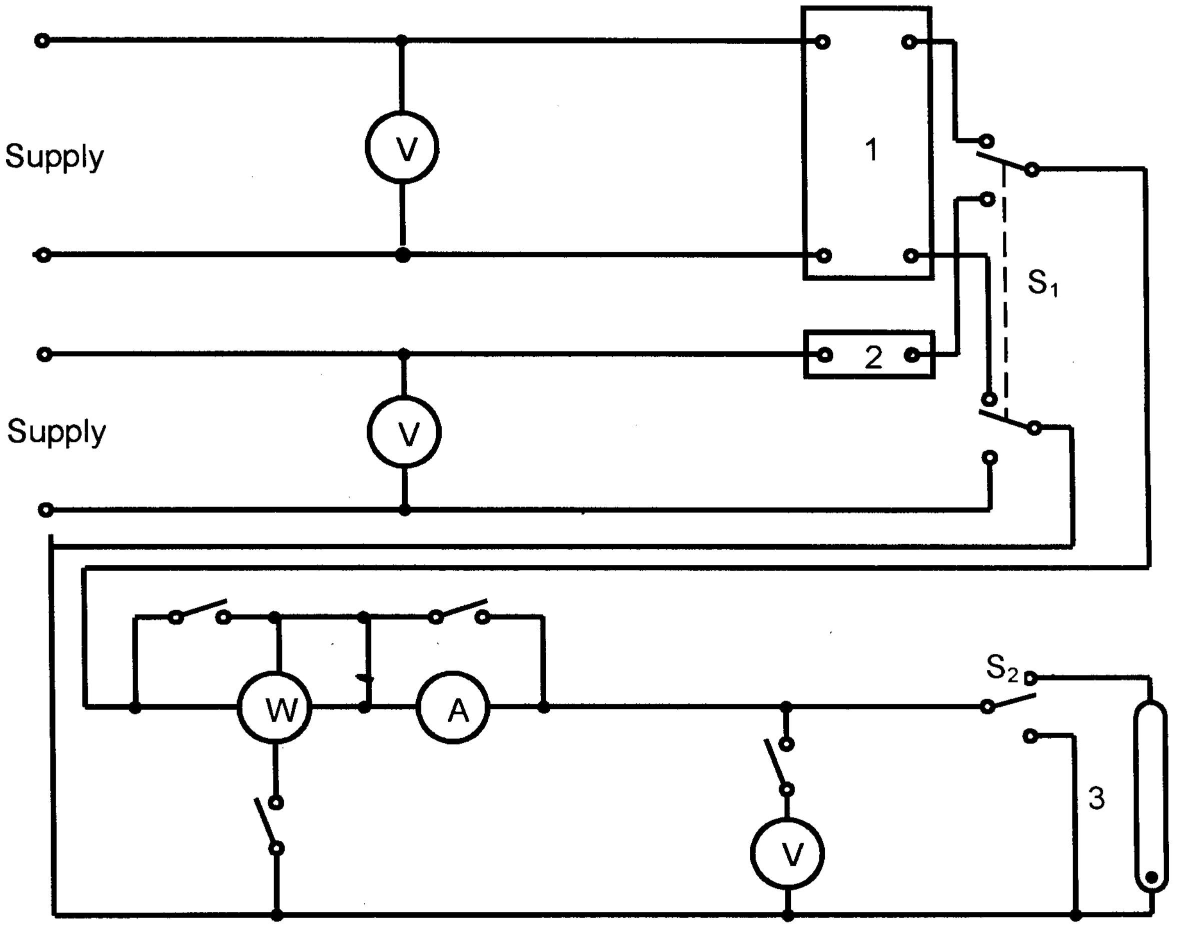
When the ballast is operated at any voltage between 92 percent and 106 percent of its rated voltage and at rated frequency, it shall provide a voltage not less than the corresponding values given in IS 9900 (Part 1) of lamps.

13 ELECTRICAL REQUIREMENTS FOR BALLASTS FOR LOW-PRESSURE SODIUM VAPOUR LAMPS

13.1 Ballast Setting

The ballast shall limit the current of a reference lamp to within 95 percent and 107.5 percent for circuits with a nominally sinusoidal lamp current waveform (for example, inductive circuits) and within X percent (*see* Note 1) and 107.5 percent for circuits with a nominally non-sinusoidal (*see* Note 2) lamp current waveform (for example, constant wattage circuits) of the corresponding value delivered to the same lamp when operated with a reference ballast. Both the reference ballast and the ballast under test shall have the same rated frequency and each shall be operated at its rated voltage.

Moreover, for any other supply voltage between 92 percent and 106 percent of its rated value, the current of a reference lamp shall lie within 93 percent and 109.5 percent for circuits with a nominally sinusoidal lamp current waveform and within *Y* percent (*see* Note 3) and 109.5 percent for circuits with a nominally non-sinusoidal (*see* Note 4) lamp current waveform of the corresponding values delivered to the same lamp by the reference ballast when supplied at 92 percent



1 = ballast under test.
2 = reference ballast.
3 = reference lamp.

NOTE — When measuring lamp wattage, no correction shall be made for the wattmeter consumption. Instruments not in use are to be short-circuited or switched off. A method for securing rapid switching of the lamp from one ballast to the other is under consideration.

FIG. 2 CIRCUIT FOR TESTING BALLASTS FOR HIGH-PRESSURE MERCURY VAPOUR AND LOW-PRESSURE SODIUM VAPOUR LAMPS

and 106 percent of its rated voltage respectively.

The test is carried out with a circuit shown in Fig. 2, with switch S_2 in the up position and switch S, successively operating the lamp from the reference ballast and the ballast under test.

NOTES

1 For circuits with a non-sinusoidal lamp current waveform, a lower minimum current limit than that for the circuit with sinusoidal lamp current waveform is under consideration.

2 For the purposes of this standard, a non-sinusoidal lamp current waveform is one with rapid current reversals. A method for specifying this current reversal is under consideration.

3 For circuits with a non-sinusoidal lamp current waveform a lower minimum current limit than that for the circuit with sinusoidal lamp current waveform is under consideration.

4 For the purposes of this standard a non-sinusoidal lamp current waveform is one with rapid current reversals. A method for specifying this current reversal is under consideration.

13.2 Short-Circuit Current and Run-Up Conditions

13.2.1 For switch-start ballasts when the ballast is supplied at any voltage between 92 percent and 106 percent of its rated voltage, the preheat current passed shall not exceed the values given in relevant Indian Standard (Under consideration).

The test circuit shown in Fig. 2 is used with switch S_1 in the up position and switch S_2 in the down position.

13.2.2 For starterless ballasts when the ballast is supplied at 92 percent rated voltage and passing the test current shown in Table 2 through a non-inductive resistor load, the ballast output voltage shall be not less than that shown in Table 2.

Table 2 Test Current

(*Clause* 13.2.2)

Sl No.	Lamp Rated Wattage W	Minimum Ballast Output Voltage V	Test Current (rms) A
(1)	(2)	(3)	(4)
i)	35	280	0.35
ii)	55	310	0.35
iii)	90	335	0.50
iv)	135	420	0.50
v)	180	470	0.50
vi)	140 (linear)	335	0.50
vii)	200 (linear)	310	1.00

13.2.3 Relevant requirements for run-up conditions for ignitor circuits are under consideration.

13.3 Open-Circuit Voltage (Minimum Voltage for Stable)

This clause is applicable to starterless ballast only.

When the ballast is operated at any voltage between 92 percent and 106 percent of its rated voltage and at rated frequency, it shall provide a voltage not less than the values given in the relevant Indian Standard.

The ratio of peak to rms voltages shall be not less than 1.4.

14 ELECTRICAL REQUIREMENTS FOR BALLASTS FOR METAL HALIDE LAMPS

14.1 Ballast Setting

Requirements and tests are under consideration.

14.2 Short-Circuit Current and Run-Up Conditions

The ballast shall comply with the relevant maximum values for inrush-current given in relevant IEC publications. If no data is available, then the lamp manufacturer shall be consulted.

The maximum value of lamp inrush-current (peak) specified in the relevant lamp data sheets of relavant Indian Standard (under consideration) (if no data is available then the lamp manufacturer shall be consulted) shall be checked as follows:

a) Test circuit (*see* Fig. 3)

b) Components

1) *Supply* — Mains impedance shall be sufficiently low, in order not to influence the measuring results.

2) *Rectifier* — Mains rectifier, with forward voltage drop < 2 V, for example:

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3) R_{Lamp}— The resistance across the lamp, R_{Lamp} depends on lamp type and shall be calculated with the formula:

$$R_{\text{Lamp}} = 2\ (V_{\text{Lamp nom}} / I_{\text{Lamp nom}})$$

4) R_{Shunt}— During the test the voltage drop shall be < 1 V.

c) Test procedure

1) The ballast under test shall have a winding temperature of 25 ± 5°C.

2) Measure the peak of the current within 3 s after connecting the mains.

NOTES

1 Ignore the first switch-on current peak.

2 If it is necessary to test a ballast which has already been tested, the winding temperature of the ballast shall comply with the above-mentioned requirements.

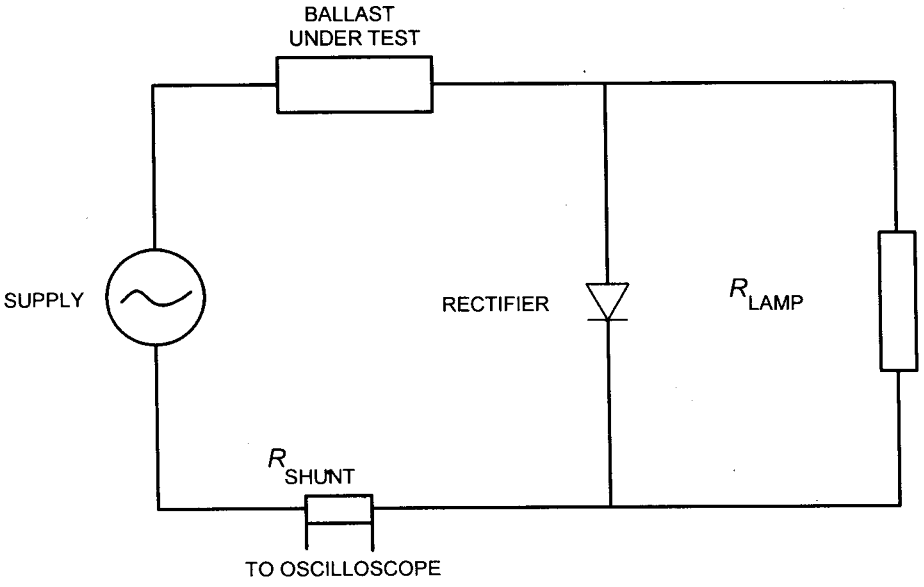

FIG. 3 LAMP INRUSH-CURRENT TEST CIRCUIT

d) Limit — The peak current, measured at nominal supply voltage shall not exceed the maximum value specified in the relevant lamp data sheets (if no data is available then the lamp manufacturer shall be consulted).

14.3 Open-Circuit Voltage (Minimum Voltage for Stable Operation)

Requirements and tests are under consideration.

15 ELECTRICAL REQUIREMENTS FOR BALLASTS FOR HIGH-PRESSURE SODIUM VAPOUR LAMPS

15.1 Ballast Setting

15.1.1 *Requirements*

The ballast shall limit the power delivered to a reference lamp, when operating at the objective lamp voltage as specified on the relevant lamp data sheet of IS 9974 (Part 2), to not less than 95 percent and not more than 105 percent of the corresponding values obtained when operating on a relevant reference ballast at the objective lamp voltage.

The lamp power value at the objective lamp voltage is to be taken from a graph of lamp power against lamp voltage plotted from the results obtained in the test procedure specified in **15.1.2** (*see also* Annex D).

15.1.2 *Test Procedure*

The requirements of Annex C shall apply.

The reference lamp shall be selected according to the requirements of Annex B. Using the relevant reference ballast, the lamp shall be started and allowed to run up.

During the run-up period, the lamp voltage and lamp power shall be recorded, either continuously or at lamp voltage intervals not exceeding 5 V, until the lamp voltage reaches a value which equals the maximum lamp voltage limit specified on the relevant lamp data sheet of IS 9900 (Part 2). Artificial means of raising the lamp voltage to the maximum limit may be necessary.

The same procedure shall be repeated, using the ballast under test, after a minimum off-period of 5 min has been observed to allow the lamp to cool.

The results obtained using both the reference ballast and the test ballast shall be plotted with lamp voltage on the horizontal axis and lamp power on the vertical axis (*see* Annex D).

Requirements for assessment at the limits of supply voltages specified in IS 9900 (Part 2) are under consideration.

NOTE — Methods of artificially raising lamp voltage are given in IS 9900 (Part 2).

15.2 Short-Circuit Current

When the ballast is supplied at any voltage between 92 percent and 106 percent of its rated voltage, the short-circuit current shall be not less than the calibration current as given in IS 9900 (Part 2).

The ratio of that ballast short-circuit current to the nominal current shall not exceed the values given in Table 3.

Table 3 Short-Circuit Current Ratio

Sl No.	Lamp Wattage W	Ratio *Max*
(1)	(2)	(3)
i)	>100	1.8
ii)	<100	2.0

15.3 Open-Circuit Voltage

When the ballast is operated at any voltage between 92 percent and 106 percent of its rated voltage and at rated frequency, it shall provide a voltage not less than the test voltage for the lamp starting test as given on the relevant lamp data sheet in IS 9900 (Part 2).

ANNEX A

(*Clause* 4)

REFERENCE BALLASTS

A-1 MARKING

The reference ballast shall be provided with durable and legible marking as follows.

A-1.1 Fixed Impedance Reference Ballasts

a) The words 'REFERENCE BALLAST' in full;
b) Identification of the responsible vendor and/ or manufacturer;
c) Serial number;
d) Lamp type, rated wattage or lamp designation and calibration current; and
e) Rated supply voltage and frequency.

A-1.2 Adjustable Impedance Reference Ballasts

a) The words 'REFERENCE BALLAST' in full;
b) Identification of the responsible vendor and/ or manufacturer;
c) Serial number;
d) Rated voltage(s) and frequency(ies);
e) Range of voltage/current ratios at rated frequency(ies);
f) Calibration current(s);
g) Maximum current per coil; and
h Connection diagram, if appropriate.

A-2 CHARACTERISTICS

A-2.1 General Design

A reference ballast consists of one or more self-inductive coil(s), with or without an additional resistor, designed to give the operating characteristics specified in the relevant lamp standard.

The measurements to check reference ballast characteristic shall not be made on the reference ballast until steady temperature conditions are reached.

Reference ballasts capable of having the voltage/ current ratio varied may be used providing compliance with this Annex is ensured.

A-2.2 Voltage/Current Ratio

When the calibration current is passed through the reverence ballast, it shall give a voltage/current ratio value as specified in the relevant lamp data sheet subject to a tolerance of ±0.5 percent at the calibration current value. At any other current between 50 percent and 115 percent of the calibration current a deviation of ±3 percent from the impedance values specified in the lamp standard is permissible.

Figure 4 gives a typical testing circuit. If this circuit is used, no correction need be made for the current drawn by the voltmeter, provided that the resistance of the voltmeter complies with the requirements of **C-5.1**.

If the frequency (f) is not exactly the rated value (f_n), a correction to the measured voltage shall be applied in accordance with the following equation:

$$\text{Voltage at rated frequency } (f_n) = \text{Voltage at frequency } (f) = \frac{f_n}{f}$$

A-2.3 Measurement of Power-Factor

Figure 5 gives a typical circuit for the determination of the power-factor. A suitable correction shall be made for instrument losses.

A-2.4 Magnetic Shielding or Magnetic Protection

The ballast shall be protected (for example, by means of a suitable steel case) against magnetic influence in such a way that its ratio of voltage to current for the calibration current shall not be changed by more than 0.2 percent when a 12.5 mm thick plate of ordinary mild steel is placed 25 mm from any face of the ballast.

The steel plate referred to above shall have dimensions at least 25 mm greater than the corresponding projection of the enclosure and shall be placed in geometric symmetry to each surface as tested.

Moreover, it shall be protected against mechanical damage.

A-2.5 Temperature-Rise

A-2.5.1 *Reference Ballasts for Lamps Up to and Including 125 W*

At the appropriate calibration current, and at an ambient air temperature between 20°C and 30°C, the steady temperature-rise of the windings as determined by the change of resistance method shall not exceed 25°C.

Any series or parallel resistor included in the ballast shall be in circuit during the heating period, but during the resistance measurements to determine the temperature-rise any such resistors shall be excluded.

A-2.5.2 *Reference Ballasts Other than Those Referred to in* ***A-2.5.1***

Reference ballasts for other types of discharge lamps which would comply with the thermal requirements in **A-2.5.1** would necessarily be large and expensive. Furthermore, the variations of the power-factor, due to the temperature-rise in normal use, have little influence on the performance of these lamps. Suitably chosen production ballasts may therefore be used provided they comply with the other clauses of this Annex.

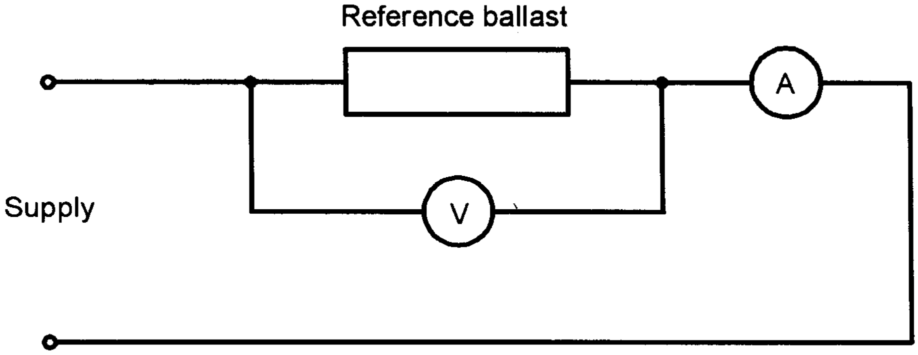

FIG. 4 RECOMMENDED CIRCUIT FOR THE MEASUREMENT OF VOLTAGE/CURRENT RATIO OF THE REFERENCE BALLAST

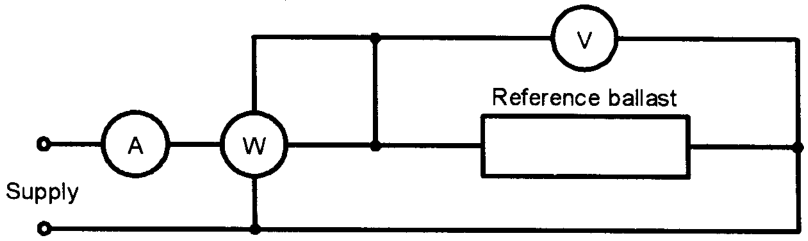

FIG. 5 RECOMMENDED CIRCUIT FOR THE DETERMINATION OF POWER-FACTOR OF THE REFERENCE BALLAST

ANNEX B

(*Clauses* 4, 15.1.2, C-4, D-1 *and* D-3)

REFERENCE LAMPS

B-1 CHARACTERISTICS

A lamp which has been aged for at least 100 h is considered to be a reference lamp, if when operated with a relevant reference ballast under conditions specified in **B-2**, it has characteristics which conform to the following requirements.

B-1.1 High-Pressure Mercury, Low-Pressure Sodium and Metal Halide Lamps

The lamp wattage, voltage and current shall not deviate by more than 3 percent from the values specified in the lamp data sheets of relevant Indian Standard.

B-1.2 High-Pressure Sodium Lamps

The lamp voltage shall not deviate by more than 10 percent from the objective voltage and the lamp power factor shall not deviate by more than 6 percent from the value calculated from the objective power, current and voltage specified in the relevant lamp data sheet of IS 9900 (Part 2).

NOTE — The lamp power factor is defined as the lamp wattage divided by the product of lamp voltage and lamp current.

B-2 OPERATION AND SELECTION OF REFERENCE LAMPS

Reference lamps shall be operated for a stabilizing period of at least 1 h in a draught-free atmosphere, at an ambient temperature of 25 ± 5°C and in the position specified below:

a) High-pressure mercury vapour lamps which are designed to operate in any position shall be operated vertically with the cap upwards;
b) Low-pressure sodium vapour lamps with a U-shaped bulb shall be mounted with the

axis slightly inclined to the horizontal with the cap uppermost; linear lamps shall be mounted horizontally;

c) High-pressure sodium lamps shall be mounted horizontally; and

d) Metal halide lamps shall be mounted horizontally or vertically according to manufacturer's instructions.

Figure 6 gives a recommended circuit for selecting reference lamps.

When measuring the voltage or power of the lamp, the potential circuit of the instrument not in use shall be open.

When measuring lamp watts, no correction shall be made for the wattmeter consumption (*see* Note) (the common connection being made on the lamp side of the current coil).

NOTE — The absence of a correction for the consumption of the voltage circuit of the wattmeter arises from the fact that in most cases, at the same supply voltage, the load compensates approximately for the reduction of the power consumption of the lamp caused by the parallel connection of the voltage circuit of the wattmeter. If the measurement accuracy is in doubt, the compensation error may be evaluated by repeating the measurement with other values of the load in parallel with the lamp. This is done by adding resistances in parallel and by reading each time the power measured by the wattmeter. It is then possible to extrapolate the results obtained in order to determine the true wattage in the absence of any parallel load.

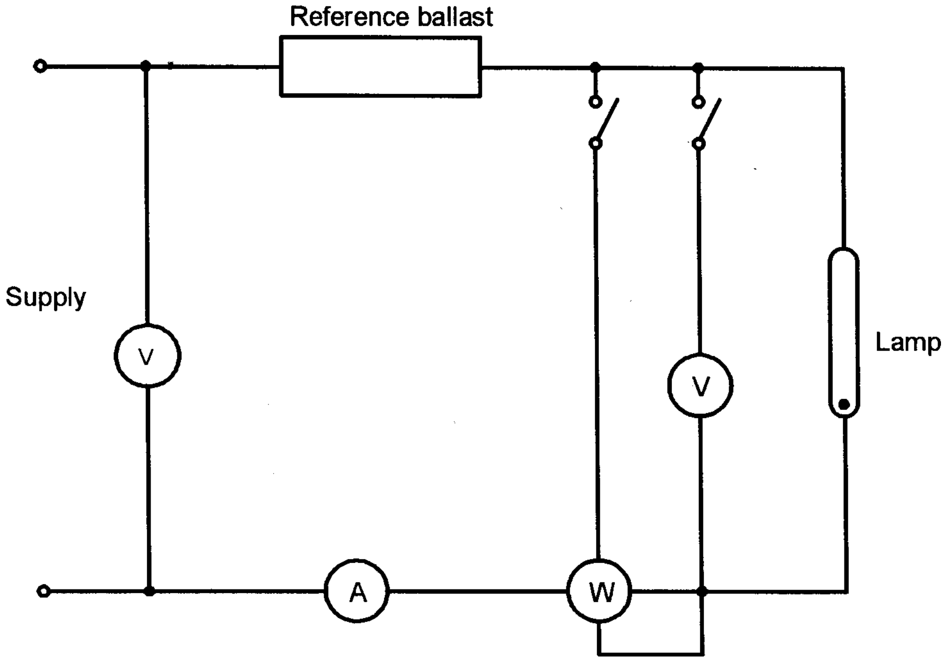

FIG. 6 RECOMMENDED CIRCUIT FOR THE SELECTION OF REFERENCE LAMPS

ANNEX C

(*Clauses* 4, 15.1.2 *and* A-2.2)

GENERAL REQUIREMENTS FOR TESTS

C-1 AMBIENT TEMPERATURE

All measurements shall be made in a draught-free room at an ambient temperature within the range of 20°C and 30°C.

C-2 SUPPLY VOLTAGE

a) **Supply Voltage and Frequency** — The reference ballast shall have the same nominal frequency as the ballast under test. Unless otherwise specified, each ballast shall be operated at its nominal frequency and at rated supply voltage.

When ballast is marked for use on a range of supply voltages or has several rated supply voltages, the most unfavorable voltage for which it is intended shall be chosen as the rated voltage.

b) **Stability of Supply Voltage and Frequency** — The supply voltage and frequency shall be maintained constant within ±0.5 percent. However, during the actual measurement the voltage shall be adjusted to within ±0.2 percent of the specified test value.

c) **Supply Voltage Waveform** — The total harmonic content of the supply voltage shall not exceed 3 percent, the harmonic content being defined as the root-mean-square (rms) summation of the individual harmonic components, using the fundamental as 100 percent.

   This implies that the source of supply shall have sufficient power and that the supply circuit shall have a sufficiently low-impedance compared with the ballast impedance.

C-3 MAGNETIC EFFECTS

No magnetic object shall be allowed within 25 mm of any face of the reference ballast or the ballast under test.

C-4 REFERENCE LAMP STABILITY

In order to obtain maximum stability for the reference lamps, they shall be mounted as indicated in **B-2**. The lamp shall be brought to a condition of stable operation before carrying out measurements. The characteristics of a lamp shall be checked immediately before and immediately after each series of tests.

C-5 INSTRUMENT CHARACTERISTICS

C-5.1 Potential Circuits

Potential circuits of instruments connected across the lamp shall not draw more than 0.5 percent of the nominal lamp current.

C-5.2 Current Circuits

Current circuits shall have sufficiently low impedance such that the whole voltage drop percent of the nominal lamp voltage.

C-5.3 Measurement of rms Values

Instruments intended for measuring rms values shall be free from errors due to waveform distortion.

C-6 CIRCUIT RESISTANCE

The measuring circuit shall have sufficiently low impedance such that the whole voltage drop, including the effect of cable resistance, does not exceed 0.5 percent of the nominal lamp voltage.

ANNEX D

(*Clauses* 15.1.1 *and* 15.1.2)

EXPLANATION OF MEASUREMENTS OF BALLAST SETTING AND LAMP-OPERATING CURRENT WAVEFORM FOR HIGH-PRESSURE SODIUM VAPOUR LAMPS

D-1 SELECTING REFERENCE LAMPS TO WIDER TOLERANCES

High-pressure sodium vapour lamps (HPS) are liable to change in characteristics each time they are operated, and therefore, the selection and maintenance of stable lamps to a close tolerance for ballast testing becomes impractical.

As a result, the usual requirements for a reference lamp as specified in **B-1.1** are inadequate and it is necessary that a wider tolerance of parameters be used to select the reference lamps (as specified in **B-1.2**).

D-2 USING A DYNAMIC SYSTEM OF MEASUREMENT FOR BALLAST SETTING (*see* 15.1)

Because an HPS reference lamp is liable to change characteristics when operated successively in the test ballast and reference ballast circuits, it is necessary to compare the lamp power when operated on each ballast at a pre-selected value of lamp voltage.

Typical ballast characteristics for a high-pressure sodium lamp operating from reference ballast and a ballast under test, with impedance set to run a nominal voltage lamp at the maximum power limit, are shown in Fig. 7. Also shown in Fig. 7 is a typical high-pressure sodium lamp characteristic slope and the value of the lamp voltage used to compare ballasts which is the objective voltage at lamp terminals as specified on the relevant lamp data sheet.

The typical HPS lamp characteristic slope shows where an ideally stable reference lamp would operate if the lamp were allowed to run up to its stable level on each ballast, the slope of the line being dependent on lamp design and manufacture.

Making the comparison at the objective voltage at lamp terminals from dynamically obtained

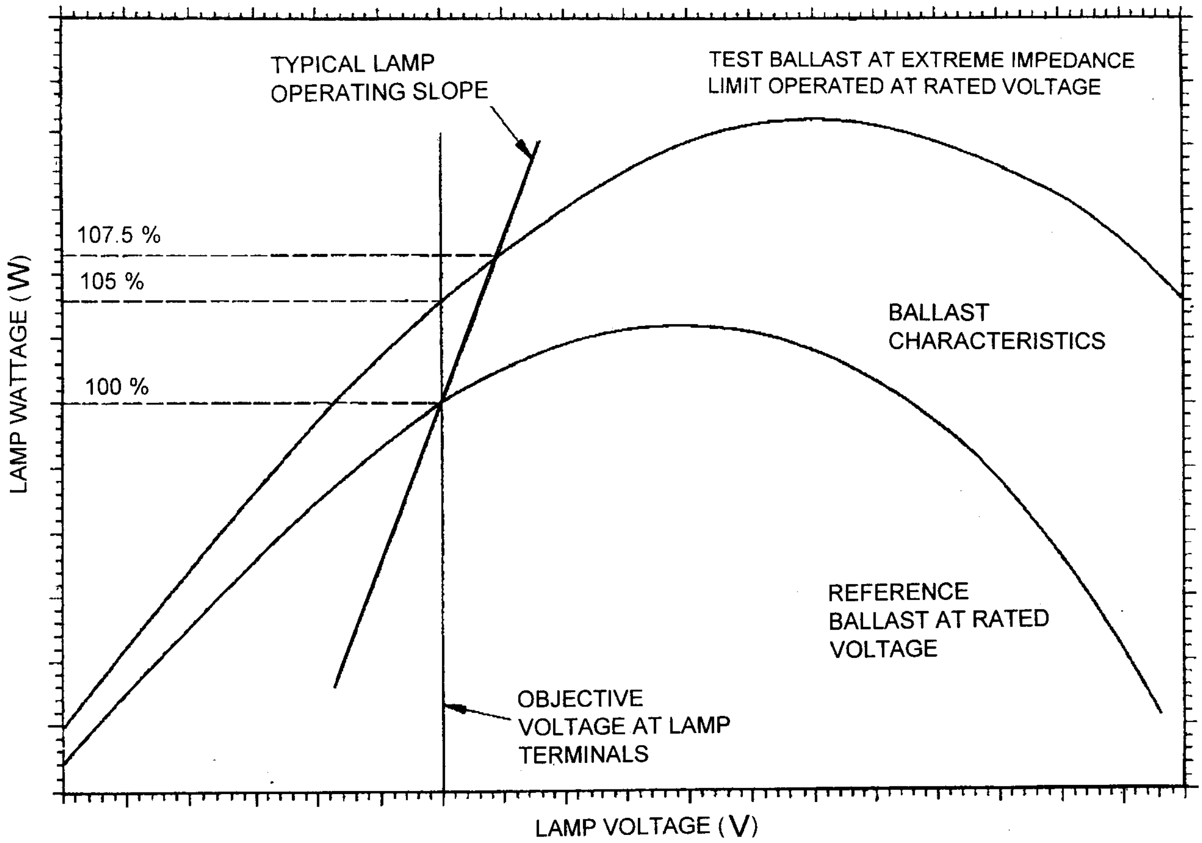

FIG. 7 LAMP VOLTAGE *versus* LAMP WATTAGE CURVE

measurements of ballast characteristics actually means comparing power in the lamp at a different part of the test ballast characteristic. A 5 percent difference from the reference ballast characteristic is equivalent to the 7.5 percent difference that would exist along an ideally stable lamp-operating slope.

D-3 LAMP CURRENT CREST FACTORS

Reference lamps selected in accordance with **B-1.2** give no significantly detectable differences in measured lamp current crest factor for given ballast, even when selected at the extremes of the objective lamp voltage limits.

ANNEX E

(*Informative*)

INTERPRETATIONS

E-1 THERMALLY PROTECTED INDEPENDENT BALLASTS

Based on the requirements of Annex N of IS 10322 (Part 1), thermally protected independent ballasts that comply with the following requirements can have the F marking:

a) Requirements in IS 15885 (Part 1) for ‘class P’ ballasts or,

b) Requirements in IS 15885 (Part 1) for ‘temperature declared thermally protected ballasts with a rated maximum case temperature of 130°C or lower’.

NOTES

1 The temperature for the judgement is not the maximum case temperature of the ballasts but the highest temperature of any part of the surface on which the ballast is mounted [*see* **12.6.2** of IS 10322 (Part 1)].

2 The temperature test should be carried out in accordance with IS 10322 (Part 1).

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